DENTAL AMALGAM
& THE MERCURY POISONING CONTROVERSY

DO YOU HAVE MERCURY AMALGAM FILLINGS IN YOUR TEETH?

DO YOU RECOGNISE THE SYMPTOMS LISTED IN THIS ARTICLE?

NEW RESEARCH NOW QUESTIONS THE SAFETY AND EFFECTIVENESS OF MERCURY AMALGAM AS FILLINGS FOR DENTAL CAVITIES.

READ THIS IF YOU DARE!

Dr. Ronald S. Laura, Professor in Education, University of Newcastle

John F. Ashton, Education Department University of Newcastle

Despite persistent assurances from dental associations around the globe that dental amalgam presents no threat to health, the use of mercury in dental fillings is now the centre of lively debate. Silver-mercury fillings have been used in the service of dental therapy since the early 1800's, but until recently, the worry that the mercury content of fillings might be slowly poisoning their recipients has lacked a sufficient basis in research to make the charge scientifically audible. Much literature has now accumulated, however, to show that the use of mercury in dental therapy may constitute yet another health hazard resulting from our obsession with chemical technology at nature's expense.

MERCURY AND ITS USE IN MEDICINE

Mercury and its compounds have been associated with medical treatments for over two millennia particularly in the areas of birth control and as a cure for syphilis. In ancient Greece, large quantities of elemental mercury were taken orally to cause abortion. Later other mercurial compounds were used. Until recently, both organic and inorganic mercury compounds, being spermicides, have been used in contraceptive tablets, jellies, and vaginal douches. Even after the introduction of birth control pills, several mercurial preparations remained on the market.[1]

Following the plagues of syphilis which spread through Europe after 1493AD, death from mercury overdose was not uncommon and it has been suggested that the behavioural abberations of a number of European kings and nobles since the 16th century may well have reflected the mental deterioration caused by the advanced stages of syphilis and its treatment with mercury.[2]

Despite mercury treatments, by the 17th century, syphilis was so widespread that prostitutes were occasionally sent out as a military weapon to "lay waste" to the invading armies. P. and F. D'Itri comment that

Some authorities have speculated that the ravages of the disease and its treatment with mercurials, both of which destroy brain cells, could have undermined the mental capacity and emotional stability of the entire population of

the Western World. No comparative studies of intelligence before and after the epidemics are possible, but the widespread exposure can be amply documented.[3]

The advent of the germ theory in the mid 19th century prompted the myth that mercury acted as a tonic that restored the body to its normal vigour and poisoned the germ directly. Notwithstanding the cumulating evidence in the late 1800s of the toxicity of mercury compounds, the use of mercurials as a treatment for syphilis continued to be justified by the medical profession. In 1920, John H. Stokes, Chief of Dermatology and Syphilology at the Mayo Clinic in Rochester, Minnesota contended:-

No matter in what form it is used, the action of mercury on syphilis is one of the marvels of medicine.[4]

The use of mercurials as a treatment for syphilis did not cease until the discovery of penicillin, which cures the disease in the early stages. Today, the only medical treatment which persists in using mercury is the practice of mercury amalgam filling of teeth cavities.

MERCURY AND DENTAL AMALGAM

In the early part of the 19th century a number of alloys had been tested as less expensive alternatives to gold for filling teeth cavities. One alloy called "fusible metal" consisted of bismuth, lead, tin and mercury, and melted just under the boiling point of water. The melted mixture was poured into the patient's tooth cavity. Later, an alloy melting at 60°C was used. Small pieces of the metal were placed on the tooth and touched with a hot instrument to cause it to melt and flow into the cavity. Burns to the mouth and face were direct hazards of these early mercury alloy treatments.

However, a French dentist M. Taveau, in 1826 used powder filed from silver coins and mixed with mercury to form a soft putty which later hardened. This putty could be placed in the teeth cold and easily shaped. Initial problems involved the swelling of the fillings but better alloy mixtures and techniques were soon developed. When the technique was brought the United States in the 1830s it touched off a controversy which has since been called the "The Great Amalgam War" between dentists preferring the new amalgam treatment and dentists advocating the gold only. The latter group vigorously attempted to discredit mercury amalgams by contending:

that the poisonous element could endanger the patients health.[5]

Subsequently, the newly formed American Society of Dental Surgeons requested members to sign a pledge refusing to use amalgams.[6] It was not until 1895 that the question of amalgam composition was settled by Dr. G.V. Black of Northwestern University, who after years of research demonstrated the proper quantities of mercury in amalgam to make an effective restorative material.[7]

The use of mercury amalgams was not further questioned until 1926 when Professor Alfred Stock at the Kaiser-Wilhelm Institute of Chemistry found evidence indicating that mercury could be absorbed from dental amalgams and that this had led to serious health problems. He concluded his findings with the remarks:

Dentistry should completely avoid the use of amalgam for fillings or at least not use it whenever this is possible. There is no doubt that many symptoms: tiredness, depression, irritability, vertigo, weak memory, mouth inflammations, diarrhoea, loss of appetite and chronic catarrhs often are caused by mercury which the body is exposed to from amalgam fillings, in small amounts, but continuously. Doctors should give this fact their serious consideration.. It will then likely be found that the thoughtless introduction of amalgam as a filling material for teeth was a severe sin against humanity.[8]

Professor Stock is reported to, some years later, have repudiated his earlier claims[9], however this repudiation is disputed and may have actually been a translation error.[10]

The reassurances of the inertness and safety of dental amalgams continued to prevail until the late 1970s when H.A. Huggins, in the light of the new public awareness of the extreme toxicity of mercury compounds brought to public attention as a result of several man made environmental mercury disasters once again pointed to the possible toxic contribution from dental fillings.[11]

MERCURY IN THE ENVIRONMENT - WARNING SIGNS

Although mercury compounds had been known to be poisonous for two millennia, the lack of appreciation of the nature of mercury toxicity, whereby exposure to extremely small amounts of mercury over long periods of time is not only very harmful but accumulates during this exposure in the brain and other tissues, led to a carelessness in industrial practices which has resulted in untold human suffering and tragedy.

Exposure of workers to mercury nitrate which figured in the carrotting process of fur felt was commonplace, as were the toxic side-effects upon those who were exposed. The phrase 'Danbury Shakes' is still used in some parts of the USA, and derived from the civil war production of soldiers' hats in Danbury, Connecticut. The phrase was intended to caricature the condition of muscle tremor and spasm caused by neurologic damage which accompanied the madness associated with industrial mercury exposure. The character of the Hatter in Lewis Carroll's Alice's Adventures in Wonderland was of course intended to reflect the severe mental disturbances manifest by people working in the fur felt hat industry.

Despite these obvious warning signs of last century, the implementation of the 20th century industrial chemical technology has meant a steadily increasing contribution of man made mercury compounds to the environment. Mercury based chemicals have been used as fungicides to treat grains, as pesticides for vegetables particularly potatoes, as mildew inhibitors in household water based latex paints, as a wood preservative, as an anti-sliming agent in wood pulp processing, as a catalyst in the production of a number of plastics including PVC and in the production of major chemicals such as chlorine and caustic soda.[12]

Elemental mercury is used in a number of types of lighting tubes including fluorescent lights and neon lights, electrical switches and numerous laboratory and medical equipment from thermometers to sphygmomanometers. Thus mercury enters the environment when old light fittings are discarded, certain laboratory apparatus is broken and mercury spilled. Mercury enters our homes and workplaces from painted material. Indoor latex paint may contain up to

200ppm phenylmercury acetate (PMA) in the can, with external paints containing up to 2000ppm of PMA.[13]

Mercury enters the food chain from agricultural sprays and industrial effluents. Mercury may even enter our body directly from cosmetics and tattoos. Incredible as it may seem, the cosmetic industry continues to use mercurials with phenylmercuric acetate and mercurous chloride still being added to face creams as antiseptics.[14]

For many years authorities were little concerned about the man made mercury contribution to the environment believing that dispersed low levels were harmless.[15] These views are illustrated by the attitude of authorities investigating the Minamata disaster in Japan.

SOURCES OF MERCURY POISONING

In 1953, along Minamata Bay on Kyushu Island, cats were observed to dance, scream incessantly and often fling themselves in the sea. Three years later a six year old girl was taken to a pediatric clinic and diagnosed to have a sever nervous disorder. Soon after, a number of other patients with similar symptoms were admitted to a local hospital. When medical staff at the Minamata Health centre examined records for the region it was realised that at least 30 other people had suffered from the same symptoms with the first victim dating back to December 1953. By 1973 over 850 Minamata disease victims had been identified.[16] The poisoning was eventually traced to fish, most likely contaminated by the waste discharge into Minamata bay by a large chemical-fertiliser factory. P. and F. D'Itri comment that:

> *Although up to 2010ppm of mercury (wet weight) were collected from the mud near the factory's drainage outlet ..., this element was not initially given a high priority, because the patients did not display the familiar symptoms of inorganic mercury poisoning such as loose teeth, sore gums, and tremors.*[17]

It was not until February 1969, thirteen years after investigations were begun, that the poisoning agent was identified as methyl mercury. This extremely toxic compound was discharged together with mercury catalyst in the waste from vinyl chloride manufacture. In the meantime, Swedish scientists had shown that organisms in marine bottom sediments could also convert inorganic mercury into the highly toxic, readily absorbed, methyl mercury.[18]

Mercury is often classified as either organic or inorganic. Among the organomercurials, as the former class is called, alkylmercurials are regarded as the group of compounds most dangerous to living organisms. Widely used a fungicides, alkylmercury has been indicted in a number of incidents as the cause of untold human suffering and deaths. One major catastrophe occurred in 1972 in Iraq when seed grain treated with methylmercury, an alkylmercurial salt, was inadvertently ground into flour for bread, rather than being used merely for planting. Five hundred people died of mercury poisoning and in excess of six thousand people were hospitalised for the same ailment.[19]

Catastrophes such as these prompted renewed interest into mercury toxicity and industrial mercury exposure.[20]

The mechanism of mercury poisoning is now known to involve the oxidation to mercuric ion which can occur in biological environments. Within cells, mercuric ions act as potent nonspecific enzyme inhibitors and denaturants of protein and thereby interfere with cellular metabolism and function. Mercuric ion can also alter membrane function and transport, including the release and uptake of neurotransmitters in the brain. It appears that mercury preferentially accumulates in specific cell types in the brain.[21] The kidney is also a target organ for inorganic mercury toxicity.[22]

In 1980, B.A. Schetz, Director of Toxicological Research at Dow Chemical Company cautioned:

> *There are such things as teratogens - substances that cause harm to a developing organism at levels that are not harmful to the adult. Mercury and thalidomide, two of the most potent teratogens that have been studied, are only that - they do not cause harm to either male or female adults at the same exposure level that will harm a fetus.*[23]

R.L. Rawls, writing for Chemical and Engineering News also reported that Monsanto, another giant U.S. chemical company:

> *identifies mercury and two or three other compounds as posing particular hazards to the fetus in the work environment.*[24]

This sinister aspect of mercury toxicity highlights the need to assess the total environmental contribution of mercury to living organisms even instances that may be initially considered as small or insignificant.

MERCURY LEVELS IN NATURE - ARE THEY A CLUE?

At this point it seems appropriate to consider the natural mercury level in the environment. Mercury occurs in the environment at minute background levels or in small localised concentrated ore deposits, making it one of the least abundant metals. For example, the concentration in sea water is only 50ppm, or 0.05 parts per billion.[25] In mercury ore deposits the metal is commonly found as the sulphide and less commonly as the monovalent chloride. These ores are highly insoluble.

It seems that nature has limited the toxic impact of environmental mercury on living organisms by providing mechanisms for biological systems to cope with the extremely low background levels. Protection of the human organism involves the production of the small detoxifying proteins called metallothionines which bind heavy metals such as mercury, cadmium and lead with high affinity.[26]

On the other hand, Man, via industrial processes and agriculture continues to disseminate mercury in the environment, substantially elevating the background levels in the food chain. For example, mercury levels of 0.1mg per kg or 100ppb were found in Australian Supermarket potatoes[27] not to mention the high levels now currently found in fish.[28]

The form of the mercury also seems to be important. The mercury poisoning catastrophes recorded in past and recent histories involved man made mercury compounds or concentrated mercury salts.

A further clue is perhaps obtained from the observations of H.A. Davey and J.C. Van Moort who studied the phenomenon of mercury being deposited from the gasses emitted from the thermal

vapours of the Ngawha Springs in New Zealand. The fumarole gasses contained levels of mercury ranging from 13,000 micrograms to 270,000 micrograms per cubic meter, together with minor amounts of hydrogen sulphide and other gasses. This resulted in the mercury content of the air being sufficient to cause mercury to condense on the metallic gutters of houses nearby, particularly after cool nights. The springs themselves which contain concentrations of mercury ranging from 26ppb to 29ppb also contain a very high degree of mineralisation, with high concentrations of boron, ammonia and bicarbonate in the brines. These hot springs are used for balneal purposes for rheumatic arthritis and dermatitis. The researchers conclude their report with the revealing observation:

In spite of the high localised mercury concentrations no ill effects have been observed among the inhabitants who frequent to the balneal establishments.[29]

It seems likely that elements co-existing with mercury in Nature may in these instances contribute to either low body absorption or facilitated detoxification.

The man made contribution of mercury now can be seen to be particularly significant from two aspects. The form of the mercury may be more toxic or more readily assimilated biologically and the increased mercury background levels may begin to exceed the levels at which individuals can safely detoxify heavy metals. This latter situation undoubtedly corresponds to the reaction which is euphemistically termed "hypersensitivity" to mercury, which is pertinent to the dental amalgam issue.

The large quantities of mercury contaminants now found in the environment contribute significantly to the problem with dental amalgam for the simple reason that exposure to sufficient mercury from other sources can sensitise living organisms even to the additional though seemingly trivial quantities found in amalgam fillings. This is a point which seems invariably to be neglected by those who insist on defending the safety of silver and mercury fillings on the basis of quantities. To quote from a supplement to the Australian Dental Association News Bulletin in August 1984:

In extremely rare cases individuals may develop hypersensitivity or an allergic reaction to mercury. Symptoms may vary from a local dermatitis near recently placed amalgam restorations to a generalised erythema over the entire body.

Symptoms associated with chronic mercury intoxification may include gingivitis and neurological disturbances such as tremor and personality changes. The levels of mercury found to be released by the amalgam restorations were far below those associated with such symptoms.[30]

The point to be stressed is that environmental contaminants in the form of organic mercury can predispose the living organism to heightened sensitivity to exposure from inorganic sources.

Within the class of inorganic mercury on finds metallic mercury, the form used to produce dental amalgam for fillings. Because of its disposition to release toxic mercury vapour when agitated, metallic mercury is considered to be th most volatile form of the element. Metallic mercury vapour can be activated at room temperature merely by being compressed or heated. One reason why absorption of elemental mercury vapour into cell membranes occurs readily is because of its amenability to dissolution or solubility in blood lipids or the fats characteristically present in all human tissue. Once inhaled, mercury vapour is rapidly absorbed by the lungs and transferred to the blood in varying amounts within several minutes. The rate of mercury vapour absorption by the lungs depends partly upon the dose inhaled. The larger the dose, the less efficient the absorption factor, with smaller doses not infrequently exhibiting rates of 80% absorption. This presents another clear indication that it is naive to base the toxicity potential of mercury solely on the response of the human organism to large doses of mercury vapour.

A number of subsequent studies have now confirmed that subjects with fillings have substantially higher levels of mercury in expired air, compared with amalgamless subjects.

Once in the blood, metallic mercury passes the blood-brain barrier rapidly and after oxidation accumulates in the brain.[31]

In addition to pulmonary intake, mercury vapour can enter the body orally and can even be absorbed by the skin. Gastrointestinal absorption is not uncommon.

Another possible source of mercury poisoning is believed to result from the deterioration of dental amalgam by corrosion. This being so, it follows that mercury ions could in theory be diffused through the teeth to nerve endings and other tissue membranes in root canals and underneath the fillings.

IS THERE A CASE FOR MERCURY POISONING FROM DENTAL AMALGAM?

That the elemental mercury used in dental amalgam is capable of giving off deadly fumes of mercury vapour is incontestable; what is being resisted by many authorities is first the claim that once mixed with alloys and installed in teeth, amalgam actually gives off mercury vapour and second, that if mercury vapour is exuded by dental amalgam, the quantities are too small to be harmful. Let us see whether the weight of argument in research terms shows that the use of silver-mercury fillings in dental therapy is a health hazard.

In 1979 D.D. Gay and co-workers reported finding significantly increased mercury levels in the exhaled air of patients with amalgam fillings. After chewing, the amount of mercury collected ranged from 64 to 244 nanograms per ten exhalations.[32] A number of subsequent studies have now confirmed that subjects with fillings have substantially higher levels of mercury in expired air, (up to 50 times in one report) compared with amalgamless subjects. Furthermore, after chewing or brushing the level of mercury vapour exuded from the fillings increased yet again, often by as much as 15 times, with levels of mercury vapour up to 29 micrograms per cubic meter being reported. [33]

In the United States, 50 micrograms/m³ represents the maximum permissible industrial level for 8 hours, 5 days a week exposure to mercury vapour.[34] However, because some of the effects of chronic mercury poisoning have been found to occur in workers exposed to air-mercury levels below 50 micrograms/m³, the World Health Organisation (WHO) has recommended a health-based occupation-

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al exposure limit of 25 micrograms/m³.[35]

Exuded mercury vapour is not the only mechanism for mercury exposure in the oral cavity. Corrosion processes are also imperceptively occurring, continuously releasing small amounts of mercury. This takes place by a selective attack on the intermetallic compound with the highest half cell potential. With conventional amalgam this is the gamma 2 phase which corrodes and releases tin and mercury ions.[36]

Recently, S. Ayres has drawn attention to the findings of E.S. Lain in the early 1930s, that the electrolytic liberation of mercury from fillings is enhanced by the presence of more noble metals such as gold in the oral cavity.[37]

Amalgam fillings in direct contact with the gold in bridges or in teeth adjacent to crowns are particularly susceptible of corrosion. Since the gold serves as a cathode and the amalgam as an anode of a galvanic cell, the anodic process results in the dissolution of the amalgam metals.

A number of recent (1985) studies of dissimilar metal corrosion showed that over a 35 week period, mercury released from amalgams in contact with gold, ranged up to 1650 micrograms per square cm of amalgam surface. When different amalgams were in contact the amount of mercury released ranged from 122 to 176 micrograms.[38] Ayres concludes that:

> *The real source of danger is not the mere presence of mercury in amalgam fillings but the presence of two different metals in the mouth, such as mercury in amalgam and gold in other teeth, giving rise to an electrogalvanic current with the resultant inflammatory reaction and the release of mercury into the circulation.*[39]

Given factors such as the nature of the amalgam, the age of the filling, degree of heat and electric current generated in the mouth, coupled with the acidity of certain foods and beverages, the corrosion resistance and stability of the amalgam materials used for fillings will display variable rates of corrosion tolerance. Higher heat and higher corrosion currents will entail a concomitant increase in the vapourisation of mercury. Studies of the corrosion levels of amalgam fillings of more than ten years age have revealed depths of corrosion of 50-90 micrometers, in respect of which it is estimated that 240-560 milligrams of toxic mercury would have been released during several years of the corrosion phase.

Pleva writes:

> *Measurements on extracted teeth have shown that mercury migrates from amalgam fillings to root and jaw bone and can be enriched there. When there has been contact with gold, the level can reach more than 1200ppm (parts per million, micrograms/gram tissue)... Such concentrations must be regarded extremely toxic.*[40]

There is yet another aspect of mercury

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amalgam dental treatment to be considered.

A number of well-controlled studies have established that during the filling process with amalgam, considerable quantities of mercury vapour and mercury amalgam particulates are expelled in the oral cavity and breathing zone. Hand condensation of the fillings resulted in mercury levels up to 320 micrograms/m³ with levels up to 770 micrograms/m³ measured with mechanical condensation. Dry cutting and polishing procedures resulted in very high levels, often exceeding 1000 micrograms/m³.[41]

During these processes fine particles of amalgam may become accidently embedded in the soft tissues of the mouth. Investigations have shown that these particles of amalgam undergo progressive degradation within phagocytic cells. During this process mercury is released from the cells into the tissues. This mercury has been found to pass from the tissue fluid into the

Continued in the next issue of Nexus.

REFERENCES:

1. D'Itri, P.A. and D'Itri, F.M., Mercury Contamination: A Human Tragedy, New York, John Wiley & Sons, 1977, pp.181-197.
2. Ibid., p.187
3. Ibid., p.186
4. Ibid., p.188.
5. Langan, D.C., Fan, P.L., and Hoos, A.A., "The Use of Mercury in Dentistry: A Critical Review of the Recent Literature", The Journal of the American Dental Association, Vol.115, December 1987, p.867. See also D'Itri and D'Itri, p.211.
6. Ibid.
7. Ibid.
8. Ziff, S., The Toxic Time Bomb, Wellingborough, Northamptonshire, Thorsons Publishers Limited, 1985, p.11.
9. Langan et.al., p.867.
10. Ziff, pp.11-12.
11. Langan et.al., p.868. See also Ziff.
12. D'Itri and D'Itri, pp.29-46, and 139-168.
13. Fritsch, A.J., The Household Pollutants Guide, New York, Anchor Press, 1978, p.210.
14. D'Itri and D'Itri, pp.202-210. See also Langan et.a., p.869.
15. D'Itri and D'Itri, p.47.
16. Ibid., p.16.
17. Ibid., p.22.
18. Jensen, S., and Jernelov, A., "Biological Methylation of Mercury in Aquatic Organisms", Nature, Vol.223, 1969, pp.753-754.
19. Langan et.al., p.869.
20. See for example: Friberg, L., and Vostal, J., Mercury in the Environment:- An Epidemiological and Toxicological Appraisal, Cleveland, Ohio, CRC Press, 1972.
21. Langanet.al., p.875.\
22. Cox, S.W., and Eley, B.M., "Mercury Release, Distribution and Excretion From Subcutaneously Implanted Conventional and High-Copper Amalgam Powders in the Guinea Pig", Arch. Oral Biol., Vol.32, No.4, 1987, p.262.
23. Rawls, R.L., "Reproductive Hazards in the Workplace", Chemical and Engineering News, February 18, 1980, p.36.
24. Ibid.
25. Selinger, B., Chemistry in the Market Place, Canberra, Aust. National University Press, 1978, p.387.
26. Buist, R., Food Chemical Sensitivity, Sydney, Harper and Row Publishers, 1986, p.206. See also Cox and Eley, p.262.
27. Anon., Choice, August 1983, p.28.
28. Farrer, K.T.H., Fancy Eating That! A closer look at food additives and contaminants, Carlton, Victoria, Melbourne University Press, 1983, p.40.
29. Davey, H.A. and Van Moort, J.C., "Current Mercury Deposition at Ngawha Springs, New Zealand", Search, Vol.5 No.4, 1974, p.156.
30. Eichorn, J. "Dental Amalgam and Mercury Toxicity", Australian Wellbeing, No.18, 1987, p.93.
31. Mylander, M., Friberg, L. and Lind, B., "Mercury Concentrations in the Human Brain and Kidneys in Relation to exposure from Dental Amalgam Fillings", Swed. Dent. J., Vol.11, 1987, p.180.
32. Gay, D.D., Cox, R.D., and Reinhardt, J.W., "Chewing Releases Mercury From Fillings", The Lancet, May 5, 1979, p.985.
33. Langan et.al., pp.870-871.
34. Ibid., p.869.
35. Eley, B.M. and Cox, S.W., "Mercury Form Dental Amalgam Fillings in Patients", British Dental Journal, October 10, 1987, p.222.
36. Ibid., p.221.
37. Ayres, S., "Amalgam and Gold Dental Fillings: Reaction from Electrogalvanic Current", J. of the American Academy of Dermatology, Vol.14, No.2, 1986, p.277. See also Ayres, S., "Sore mouth caused by electrogalvanic current", J. of the Royal Society of Medicine, Vol.77, August 1984, p.709.
38. Langan et.al., p.871.
39. Ayres, 1986.
40. Pleva, J., "Mercury Poisoning and Dental Amalgam", Orthomolecular Psychiatry, Vol.12, No.3, 1983, p.190.
41. Eley and Cox, p.222.
42. Ibid., see also Eley and Cox.